

## (12) UK Patent Application (19) GB (11) 2 302 138 (13) A

(43) Date of A Publication 08.01.1997

(21) Application No 9612302.1

(22) Date of Filing 12.06.1996

(30) Priority Data

(31) 9512006

(32) 13.06.1995

(33) GB

(71) Applicant(s)

**BP Energy Limited****(Incorporated in the United Kingdom)****BP House, Langley Quay, Waterside Drive, Langley,  
SLOUGH, Berkshire, SL3 6EY, United Kingdom**

(72) Inventor(s)

**Robert John Ashley****Nicholas Andrew Gadde**

(74) Agent and/or Address for Service

**Shona Hoey****BP International Limited, Patents and Licensing  
Division, Chertsey Road, SUNBURY-ON-THAMES,  
Middlesex, TW16 7LN, United Kingdom**(51) INT CL<sup>6</sup>**F01K 13/00, F02B 65/00, F02C 9/00**

(52) UK CL (Edition O )

**F1Q QGA Q414 Q416 Q419 Q420****F1T TGX T101 T102 T122 T129 T601 T612 T619**

(56) Documents Cited

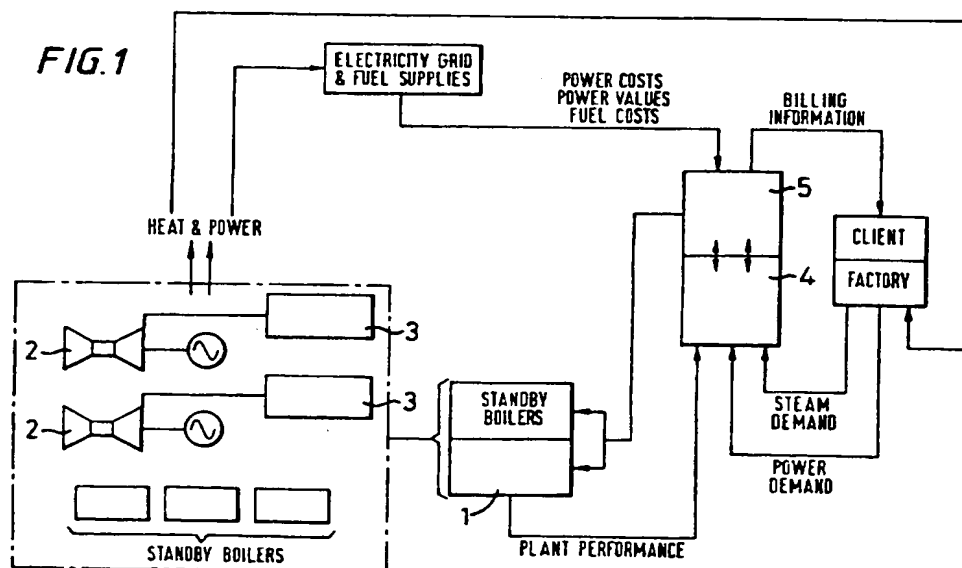
**GB 2152591 A**

(58) Field of Search

**UK CL (Edition O ) F1Q QED QGA, F1T TGB TGCX  
TGD TGX****INT CL<sup>6</sup> F01D 17/00, F01K 13/00 13/02, F02B 65/00,  
F02C 9/00 9/16 9/26 9/48 9/50 9/56****ONLINE WPI**

## (54) Combined heat and power system

(57) A combined heat and power system comprises one or more prime movers 2, (eg. a gas turbine, a steam turbine, a reciprocating internal combustion engine, or a combination thereof), means 3, (e. boilers) for beneficial use of by-product heat, a data acquisition and storage system 4, comprising a first means for receiving and storing data associated with the energy demands placed upon the system and a second means for receiving and storing data associated with costs, and financial values of fuels and power, and a data processing system 5, capable of receiving and manipulating the data obtained from the data acquisition and storage system, to provide control instructions and commercial/billing information. The data acquisition and storage function may be managed by a computer system.



GB 2 302 138 A

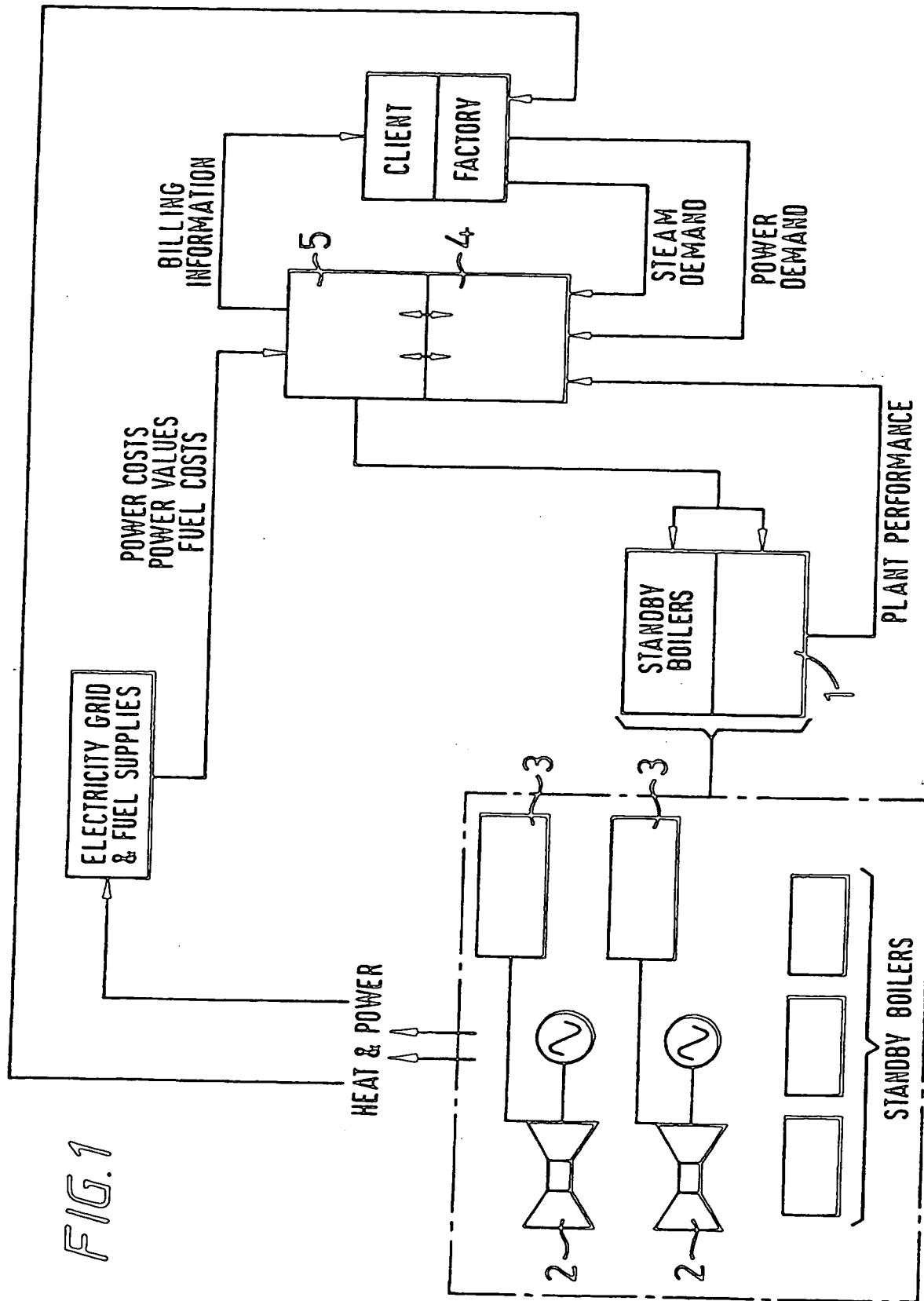


FIG. 1

### COMBINED HEAT AND POWER SYSTEM

The present invention relates to a combined heat and power system optimised using a combination of energy efficiency and economic criteria.

Combined heat and power (CHP) may be defined as the simultaneous generation of motive power (often converted to electricity) with beneficial use of the by-product heat. From a commercial stand point it may be better described as a heat load which allows cost effective power generation. CHP systems may be based on prime movers such as steam turbines, gas turbines and internal combustion reciprocating engines. These can be used singly or in multiples of one type or in combination of types. Combined heat and power is highly energy efficient and offers the resulting benefits of reduced operating costs and improved environmental performance.

If energy efficiency was the only driving force behind the application of this technology most if not all CHP plants would be programmed to run continuously. The market price of electricity is not driven purely by energy efficiency and continuous operation at full power is not always the most economic solution. If CHP technology is to be more widely applied and the energy and environmental benefits achieved, a means must be found of maximising the economic as well as the energy performance of the plant.

We have developed a combined heat and power system which succeeds in combining energy and economic rules in its operating strategy.

According to the present invention there is provided a combined heat and power system for the production of power and by-product heat which comprises:

- (1) one or more prime movers,
- (2) means for beneficial use of the by-product heat,
- (3) a data acquisition and storage system comprising a first means for receiving

and storing data associated with the energy demands placed upon the system and a second means for receiving and storing data associated with costs, and values of fuels and power, and

- (4) a data processing system capable of receiving and manipulating the data obtained from the data acquisition and storage system, to provide control instructions and commercial/billing information.

The combined heat and power system of the present invention comprises a unique data processing system which provides the capability of optimising plant efficiency by responding to fluctuations in fuel and electricity costs and energy demands. The processing system has the capability, at chosen time intervals, to analyse the large volume of real-time supply, demand, cost and price data, making calculations and providing the system with information on when and how to run the CHP plant. The processing system also has the capability of generating an invoice which has embedded in it the assumption of achievement of the optimised performance.

The combined heat and power system of the present invention comprises one or more prime movers. Suitably, the prime mover may be a gas turbine, a steam turbine or a reciprocating internal combustion engine or a combination thereof. It is preferred that the prime mover is a gas turbine.

Where the prime mover is a gas turbine, it is preferred that associated with the prime mover there is a heat recovery system. The heat recovery system may be a boiler, a drying system, a process heater, an absorption chiller, a heat exchanger or a combination thereof.

The combined heat and power system of the present invention comprises a means for the beneficial use of the by-product heat. Suitably this means is a boiler, particularly where the prime mover is a gas turbine. Alternatively, the means may be the user of the heat, e.g. the unit requiring power for operation.

The combined heat and power system of the present invention comprises a data acquisition and storage system comprising a first means for receiving and storing data associated with the energy demands placed on the system and a second means for receiving and storing data associated with costs and values of fuel and power. The data acquisition and storage function is suitably managed by a computer system operated by appropriate computing software. The first receiving and storing means may suitably incorporate flow, power and temperature meters, electronic transmission and storage of data. Factors such as power demand can change significantly and at

short notice. The data acquisition and storage system is provided with the capability of dealing with these short/long term variations.

The second means for receiving and storing data relating to costs and values of fuels and power associated with the data acquisition and storage system may also be a computer system operating appropriate computer software. The data are suitably obtained from commercial sources, e.g. contracts, covering the purchase or sale of fuels and/or power and entered into the system. Again factors such as power price can vary frequently and substantially. The data acquisition and storage system is provided with the capability of dealing with these short/long term variations.

The combined heat and power system of the present invention also requires a data processing system which is capable of receiving and manipulating the data obtained from the data acquisition and storage system. The data processing system suitably comprises one or more computers operating appropriate software. The processing system uses the data and information relating to the performance of the CHP plant, which can vary both rapidly and independently, to determine the most cost effective operating regime considering the efficiency of the plant. The processing system is then able to provide information relating to how the plant should be operated, e.g. generator power output, and billing information for the utilities supplied.

A particular advantage of the data processing system is its ability to operate over a range of time periods, e.g. 30 minutes interval, currently used in the UK power supply industry. A further advantage is that whilst all the plant process data are retained within the system, the opportunity is provided to re-run the processing system routine which allows process audit and invoice generation off-line.

The invention will now be described by way of example with reference to Figure 1 which is a diagrammatic illustration of the combined heat and power system.

Figure 1 illustrates a heat and power system (1) which comprises two gas turbines (2), each with associated waste heat recovery boilers (3). The turbines (2) and the boilers (3) are controlled by separate programmable logic controllers(not shown). The heat and power system (1) is linked to the data acquisition and storage system (4) and the data processing system (5) comprising one or more computers. Data on heat and power demands are collected from the factory and passed to the data acquisition and storage system (4). Data concerning the fuel and power prices and values are passed to the data acquisition and storage system (4). Information concerning the performance of the CHP plant is input to the data processing system (5). The data processing system (5) outputs set points for CHP plant control and

invoices for services provided.

In a specific embodiment of the present invention, the data acquisition and storage means (4) is by means of proprietary programmable logic controller (PLC) duplicated. The economic simulation, control and billing function is by means of a  
5 Pentium PC. The power, cost and value data are acquired through a dedicated portable computer receiving information broadcasted by NGC. The portable computers use a combination of software packages and bespoke programming. The main elements of the software comprise Windows environment (Microsoft Ltd), Wonderware In Touch Interface, Net DDE data interface and Excel spread sheet  
10 (Microsoft Ltd).

In use the control and optimisation system combines real time energy demand data, real time energy cost and value data and plant performance information in an economic simulation model to output both plant operating instructions and billing information for the energy supplied.

15 The economic simulation compares a substantial number of potential CHP plant operating regimes. For each regime it calculates the total cost of providing the energy supplied taking into account the energy demand patterns and energy costs and values for the metering period. The regime with the lowest operating cost for the period is selected. The model also identifies the configuration required to produce this lowest  
20 operating cost and stores the control instructions. The plant is controlled according to this minimum operating cost regime and a bill is prepared based on the assumed achievement of that lowest operating cost.

25

30

35

Claims

1. A combined heat and power system for the production of power and by-product heat which comprises:

(i) one or more prime movers

(ii) means for beneficial use of the by-product heat

5 (iii) a data acquisition and storage system comprising a first means for receiving and storing data associated with the energy demands placed upon the system and a second means for receiving and storing data associated with costs, and values of fuels and power; and

10 (iv) a data processing system capable of receiving and manipulating the data obtained from the data acquisition and storage system, to provide control instructions and commercial/billing information.

2. A combined heat and power system as claimed in claim 1 in which the prime mover is a gas turbine, a steam turbine or a reciprocating internal combustion engine or a combination thereof.

15 3. A combined heat and power system as claimed in claim 2 in which the prime mover is a gas turbine.

4. A combined heat and power system as claimed in claim 3 in which there is a heat recovery system in association with the gas turbine.

20 5. A combined heat and power system as claimed in any one of claims 1 to 4 in which the means for beneficial use of the by-product heat is a boiler.

6. A combined heat and power system as claimed in any one of claims 1 to 5 in which the data acquisition and storage function is managed by a computer system.



The  
Patent  
Office

6

Application No: GB 9612302.1  
Claims searched: 1-6

Examiner: C B VOSPER  
Date of search: 11 September 1996

Patents Act 1977  
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F1Q(QED.QGA); F1T(TGCX.TGD.TGX, TGB)

Int Cl (Ed.6): F01D 17/00; F01K 13/00,13/02; F02C 9/00,9/16,9/26,9/48,9/50,9/56;  
F02B 65/00

Other: ONLINE WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB2152591A GENERAL (page 5, lines 46 to 51) (Equivalent - US4891948)	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.